METHOD OF TEST
MODIFIED PROCTOR MOISTURE-DENSITY RELATIONSHIP OF SOILS
FIELD PROCEDURES FOR LABORATORY TEST METHOD 104

SCOPE

This method of test is intended for determining the relationship between the moisture content and density of soils or flexible base materials compacted according to a standard procedure, AASHTO T-180, Method C.

PROCEDURE

A. Apparatus

1. Metal mold, tapered from 101.6 mm to 103.5 mm (4 in. to 4.075 in.) in diameter and 114.3 mm (4.50 in.) in height, with base plate and collar.

2. Scale, capable of weighing at least 5000 grams and sensitive to 0.5 gram.

3. Compaction device, consisting of a 4.54 kg (10 lb.) hammer, and rod, enclosed in a guide tube providing a 450 mm (18 in.) hammer drop.

4. Drying equipment, preferably an oven capable of maintaining a temperature of 110°C ± 5°C (230°F ± 9°F) or a hot plate.

5. Straight edge A hardened steel straightedge 225 mm (9 in.) long. It shall have one beveled edge for cutting and at least one longitudinal surface for trimming.

6. Mixing Equipment. A stainless steel mixing pan, long handled spoon, rubber mallet, putty knife, 500 cc graduate and scoop.

7. Sample Extruder (Jack or Lever Frame)

8. Sieves 19 mm (¾ in.) and 4.75 mm (#4)

9. Moisture pans (tared)

B. Calibration

1. Keep the tube interior and surface of the hammer clean at all times to insure a fixed, free fall of 450 mm (18 in.).

2. Steel mold need not be calibrated for it will retain its volume of 0.0009 m^3 (α Off^3) unless damaged or machined.

C. Sample Preparation

1. Quarter the field sample to a representative sample 5,000 to 6,000 grams.

2. Spread the sample out and allow it to dry to a moisture content of at least 5% below the estimated optimum moisture content.

3. Screen the sample over 19 mm (¾ in.) sieve and replace the retained aggregate with an equal mass of 4.75 mm to 19 mm (No. 4 to ¾ in.) material from the original field sample.

D. Test Procedure

1. Pulverize the prepared sample so that 90% of all material except aggregate will pass the 4.75 mm (No. 4) sieve.

2. Place sample in the mixing pan and sprinkle water on the sample while stirring. The sample is ready for compaction when, after thorough mixing, a handful of soil that has been squeezed tightly in the palm of the hand will barely hold together when pinched between the fingers.

3. With the assembled mold resting on a solid surface, weigh and place in the assembled mold an amount of the sample, which, after compaction will yield slightly more than 1/5 the height of the mold.

4. Place the hammer and guide tube assembly lightly on the top of the loose soil.

5. Distribute twenty-five blows uniformly over the soil, by raising the hammer to the top of the guide, stop and then allowing it to fall freely. Take care in this operation not to allow the tube to restrict the free fall of the hammer.

6. Make a measurement to determine if a slight excess over that needed to fill 1/5 of the mold is obtained.

7. Adjust the mass of the soil taken for the second layer as needed to achieve the desired height and compact the same as the first layer.

8. Repeat this process for all 5 layers. Do not allow any sample material to build up on the bottom of the hammer or on the inside of the guide tube.

9. Following compaction, remove the collar and carefully trim the excess material to the level of the top of the mold, using the straight edge. Fill any holes resulting from the removal of large particles with smaller size material.

10. Remove the mold from the base plate and weigh using a mold counter balance. Multiply the mass of the compacted sample by 1.0595 for kg/m^3 (0.0661 for $lb./ft.^3$) and record the result as the wet density in grams per cubic meter (pounds per cubic foot) of compacted soil.

11. Remove the specimen from the mold and slice vertically through the center. Take a representative sample of the specimen from one of the cut faces, weigh immediately in a tared pan and dry to constant mass on hot plate or dry overnight in an oven at 110°C ± 5°C (230°F ± 9°F). The moisture content sample shall weigh not less than 500 g for most soils and 700 g for crushed stone and gravel.

12. Thoroughly break up the remainder of the specimen, return it to the remaining sample in the pan, and add water to increase the moisture content of the soil sample by 1 or 2 percentage points. Repeat the compaction procedure as above for each increment of water added. Confine this series of determination until there is a decrease or no change in mass (weight) of the compacted specimen.

E. Calculations

1. Calculate the moisture content and the dry mass of soil as compacted for each trial as follows:

$$w = \frac{A - B}{B - C} \times 100 \qquad W = \frac{W_1}{W + 100} \times 100$$

Where:
- w = percentage of moisture in the specimen.
- W = Dry Density in kg/m^3 ($lbs./ft.^3$) of compacted soil.
- W_1 = Wet Density in kg/m^3 ($lbs./ft.^3$) of compacted soil.
- A = Mass of moisture pan and wet soil.
- B = Mass of moisture pan and dry soil.
- C = Mass of moisture pan

2. Plot the results of the above calculations with dry densities in mass (weight) per cubic meter (foot), plotted as ordinates and the corresponding moisture contents as abscissas. Connect the plotted points with a smooth curve and report the peak of the curve as "optimum moisture content" and "maximum density."